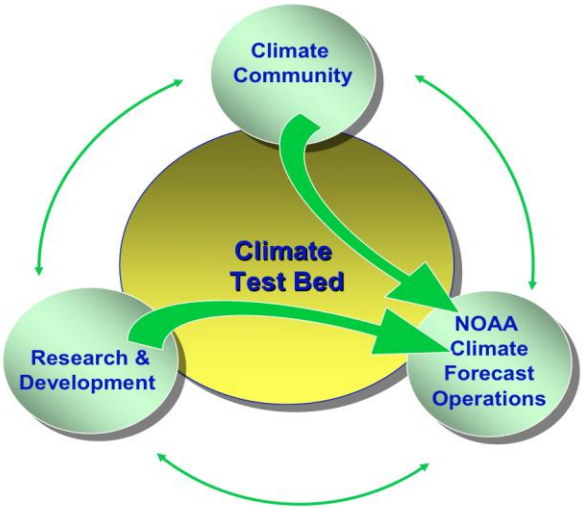
NOAA Climate Test Bed (CTB) Report and Future Plan

Jin Huang

November 16, 2012



Mission: To accelerate the transition of scientific advances from the climate research community to improved NOAA climate forecast products and services.

http://www.cpc.ncep.noaa.gov/products/ctb/

Outline

1. **CTB Overview**
2. **Progress and future activities**
3. **Issues and plans to improve R2O transition**
4. **Summary**

CTB Mission and Objectives

Mission: *To accelerate the transition of scientific advances from the climate research community to improved NOAA climate forecast products and service*

CTB Objectives:

- to **accelerate the synthesis and implementation of advances** in climate model improvements, multi-model techniques, forecaster tools, data sets, and observing systems

- to **provide the climate research community with access to operational models, forecast tools and data sets**

- to **develop new and improved operational climate forecast products** for the applications community to use in planning and decision making.

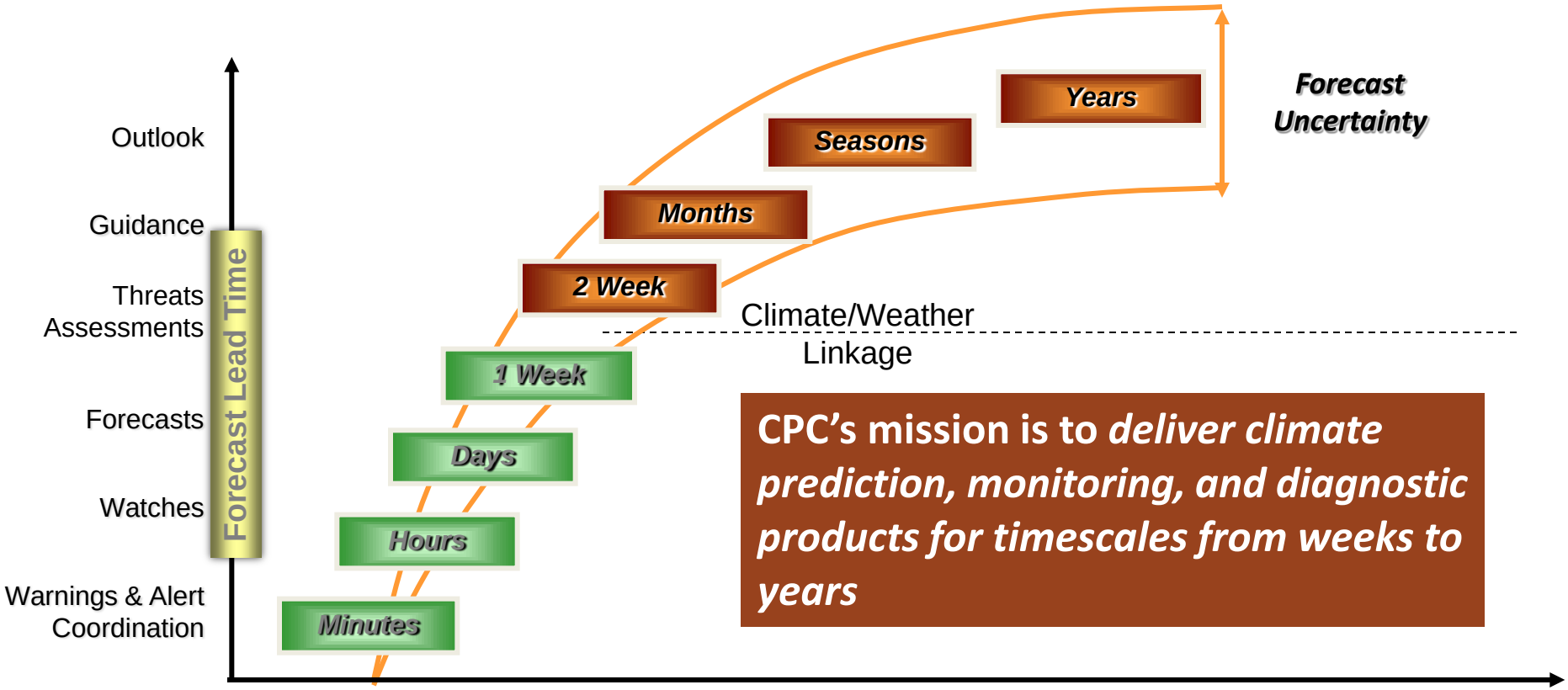
What does CTB do?

CTB Current Priorities:

1. Multi-Model Ensembles
2. CFS Improvement
3. Climate forecast tools/products

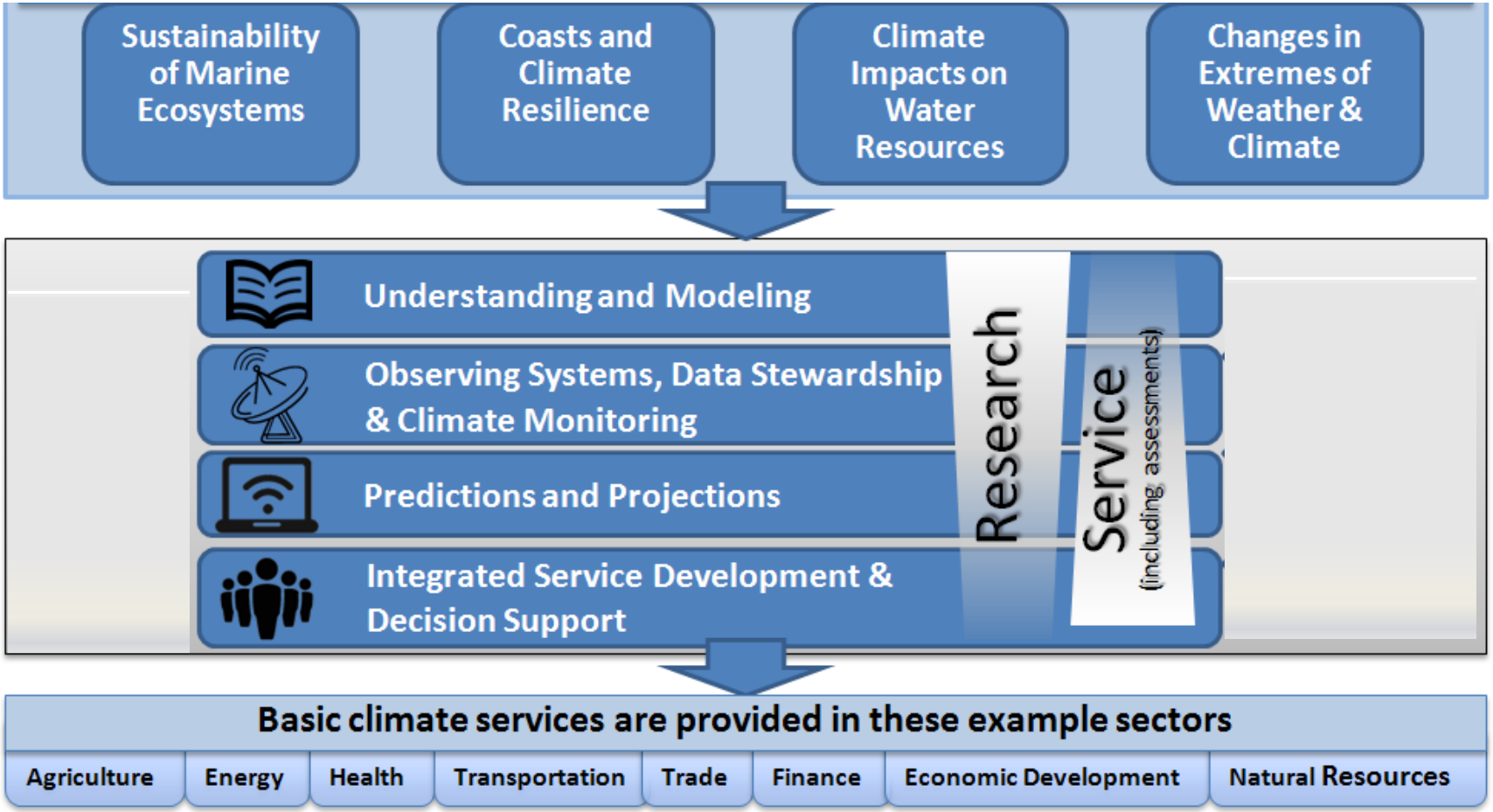
- ***Basic Research***
- ***Applied Research***
- ***Research to Operation (R2O) Transition***
- ***Operations***

CTB Contributions to NOAA Seamless Suite of Forecast Products



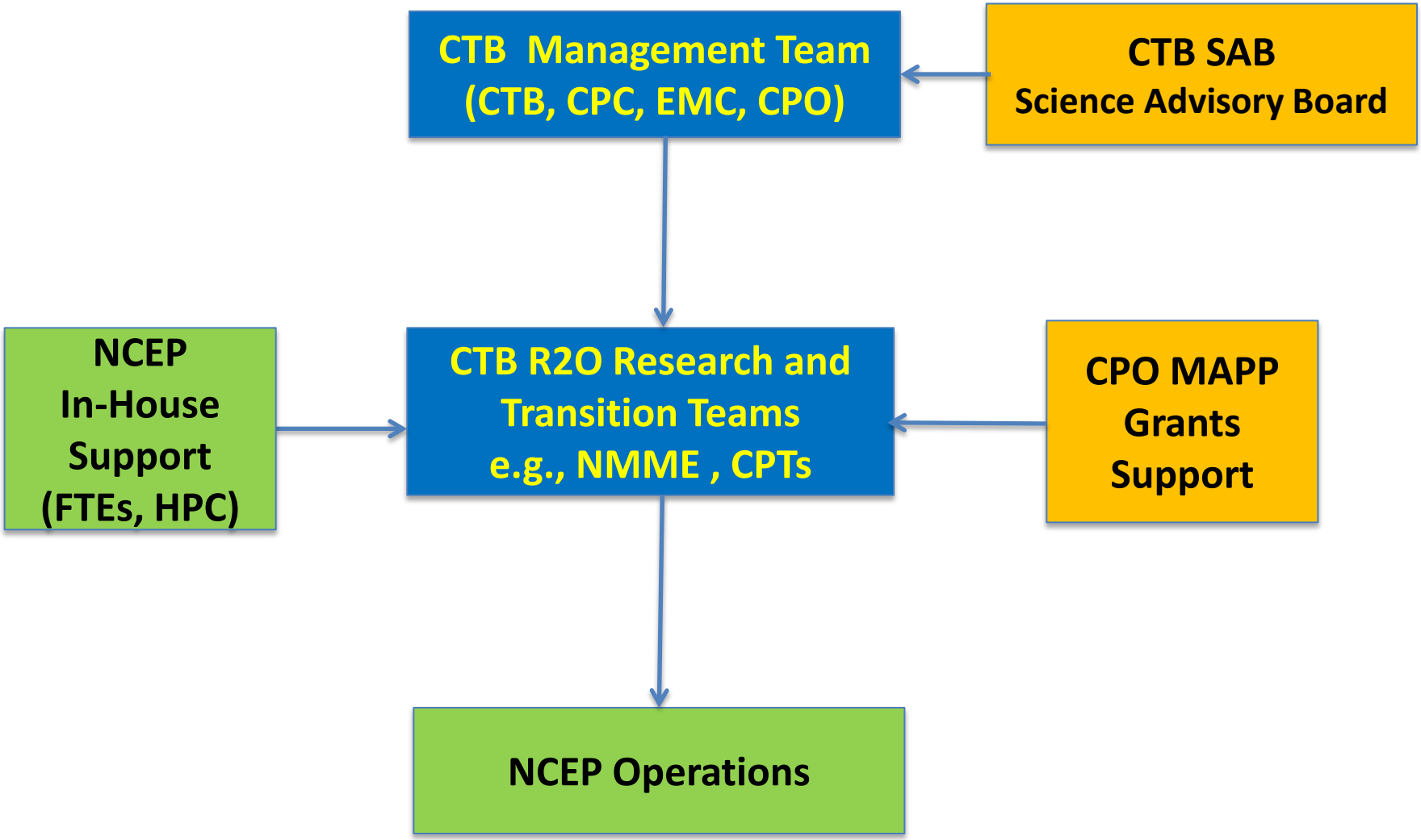
- **CTB's mission is to improve *climate forecast products and service on timescales from weeks to years by accelerating R2O transitions.***
- **CTB priorities are driven by the requirements of NOAA operational forecasts**

NOAA Climate Priority Areas



CTB contributions to NOAA Climate Priority Areas by accelerating improvements of NCEP's products and services

How Does CTB Function?



NCEP – CPO MOU

Respective Roles of CPO and NCEP in Advancing Intraseasonal-to-Interannual Climate Modeling and Prediction

- **CPO provides and manages support for research (R**) to both the extramural community and NOAA labs / centers participating in the ISI climate arena.

- **NCEP delivers operational (O)** national and global weather, water, climate and space weather guidance, forecasts, warnings, and analyses to its partners and the external user communities.

- **The CTB executes end-to-end transition activities** with grant support from CPO and infrastructure support from NCEP.

- CPO provides funding to research activities of mutual interest and of high priority identified by CPO, mindful of the priorities stated by NCEP in its strategic plan and related documents

CTB Science Advisor Board (SAB)

provides independent scientific advice, broad direction and endorsement of ongoing and planned activities

Current CTB-SAB Members:

1. T. Barnston (IRI)
2. T. Busalacchi (U. Maryland, Chair)
3. E. Harrison (PMEL)
4. M.Harrison (UK)
5. J. Kinter (COLA)
6. R. Koster *(NASA)
7. K. Redmond (DRI)
8. T. Rosati (GFDL)
9. S. Sorooshian * (U. California at Irvine)
10. J. Tribbia (NCAR)

* new member

CPO CTB Grants Program

- **Annual CTB priorities are decided by CPO, mindful of CTB priorities**
- **NCEP partners (Co-Is) are required**
- **FY06 - FY10: CTB Grants Program and CTB Annual Calls for Proposals at CPO**
- **FY11 – FY13: CTB projects supported by CPO/MAPP**
- **FY13: Implementing MAPP-CTB Execution Agreement**
  - **Specific metrics to measure the progress**
  - **Post-project reviews**

NCEP Infrastructure Support

Computer resources:

- FY06 - FY10: dedicated HPC (1/3 Vapor)
- FY11 – FY13: proposal based; no dedicated HPC

FTEs

- No dedicated FTEs besides the CTB director position
- Leveraging CPC and EMC FTEs in an ad hoc manner

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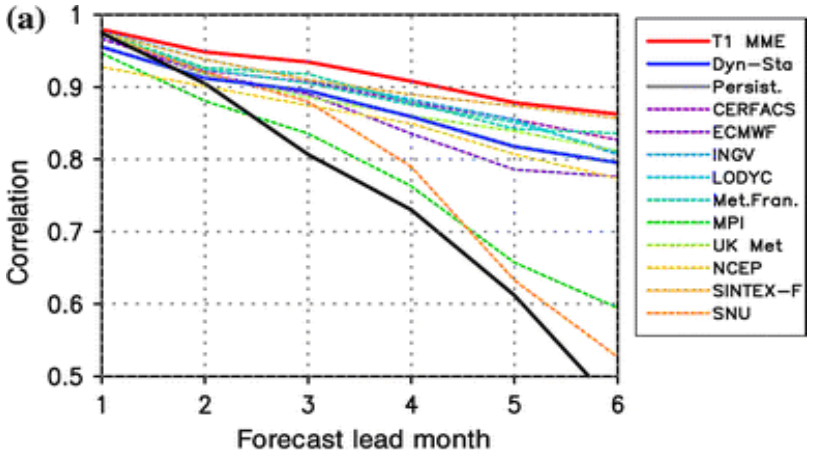
CTB Priority (1): Multi-Model Ensembles

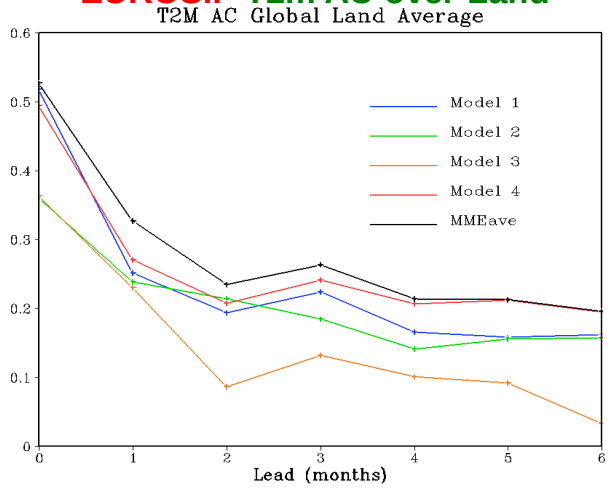
Goal: A multi model ensemble prediction system that leverages the best national and international models for improved predictions on intraseasonal-to-interannual time scales

- MME outperforms individual models
- CTB supported several more research focused projects on verification and consolidations during FY08-10
- EUROSIP (International MME) is beneficial to operational forecasts, but data is not open to the research and user communities

ENSEMBLE ENSO Prediction



EUROSIP T2m AC over Land



NMME - Phase I

- NMME of Opportunity
- Established collaborations in US and developed the protocol for an experimental NMME forecast system
- Realtime experimental Forecast
- Monthly NMME data to the public

NMME Partners

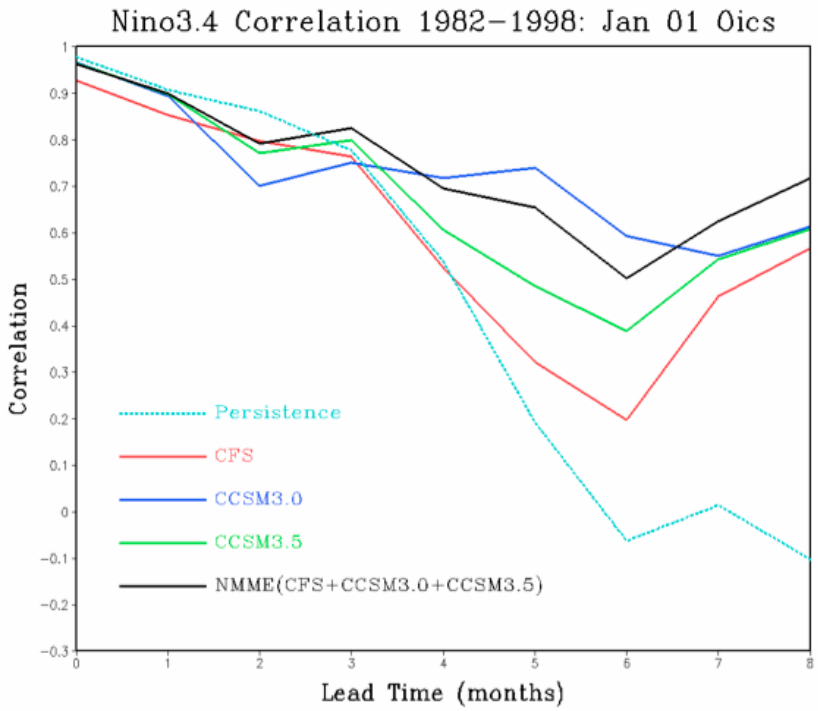
- **University of Miami**
- **COLA**
- **NCAR**
- **IRI**
- **U of Colorado – CIRES**
- **NASA – GMAO**
- **NOAA/NCEP (CPC & EMC)**
- **NOAA/GFDL**
- **Princeton University**
- **Canada**

Funded by CPO/MAPP Program in FY11

Previous CTB Projects Contributed to the development of NMME

MME (CFS + CCSM3.0)

(Kirtman and van den Dool, FY08)



This project is a prototype for NMME

- The consolidation Methodology developed by the CTB PIs has been used in CPC operational forecasts to objectively combine various forecast tools (**van den Dool, FY08)**
- Recalibrating and combining ensemble predictions will be used for NMME **(Goddard, FY08)**

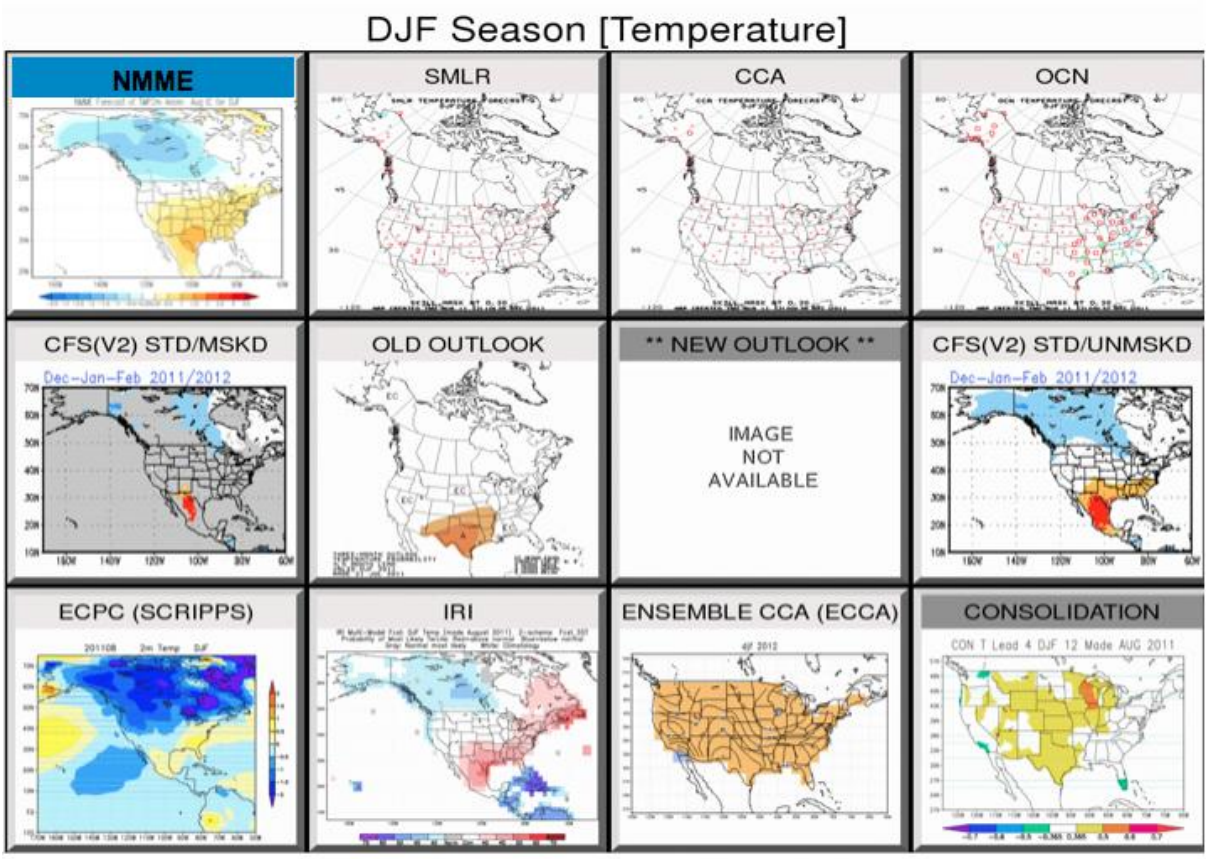
CPC Real-Time Seasonal Forecasting Tools

Operational CPC Forecasts

Monthly Ocean Briefing

Monthly Drought Briefing

Used for African Desk

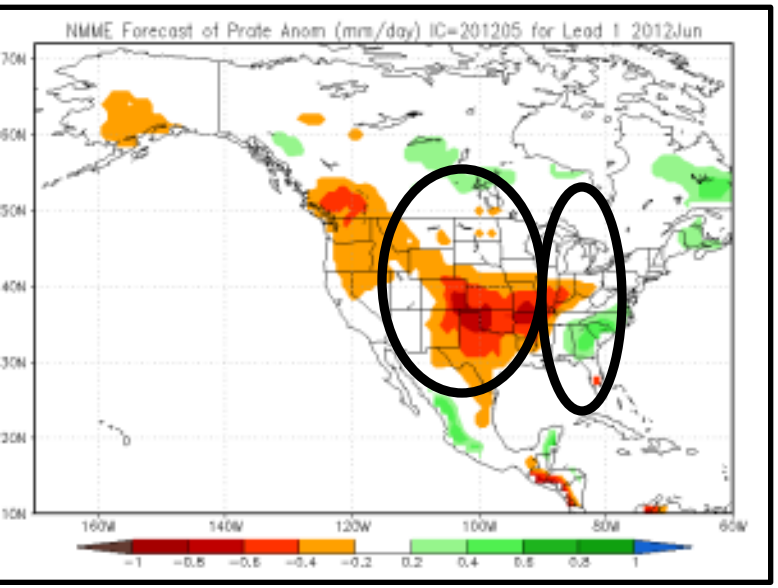


CPC Seasonal Prognostic Map Discussion (PMD):

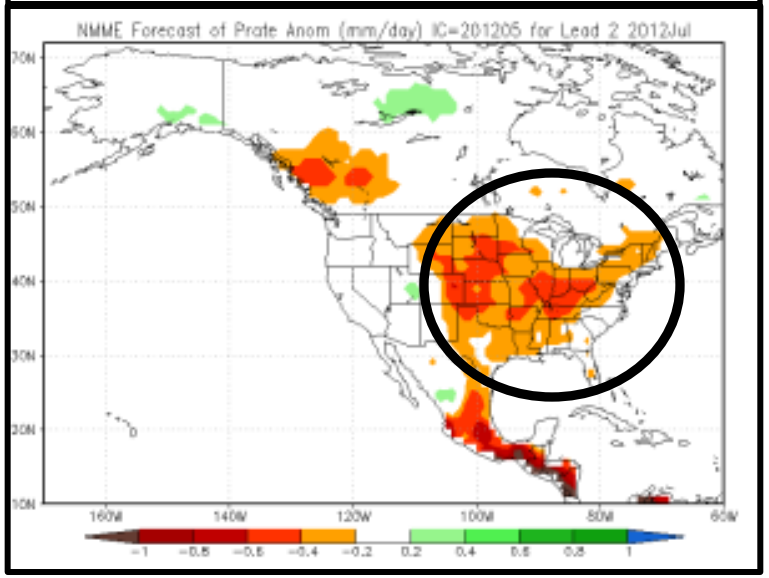
"PROGNOSTIC TOOLS USED FOR U.S. TEMPERATURE AND PRECIPITATION OUTLOOKS FOR JFM THROUGH AMJ 2012 WERE PRIMARILY BASED ON THE NEW NATIONAL MULTI-MODEL ENSEMBLE MEAN FORECAST (NMME). THE FORECASTS STRONGLY AGREE WITH …"

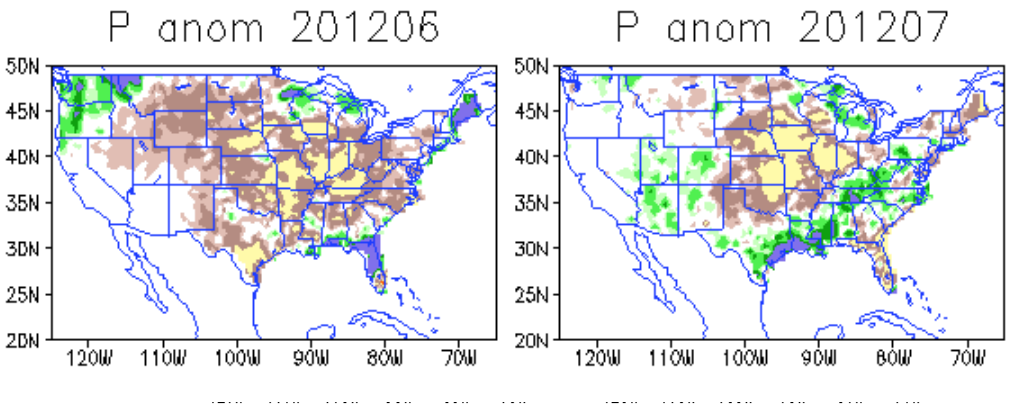
NMME Captured the 2012 Drought over East-Central US

Lead 1: June 2012



Lead 2: July 2012





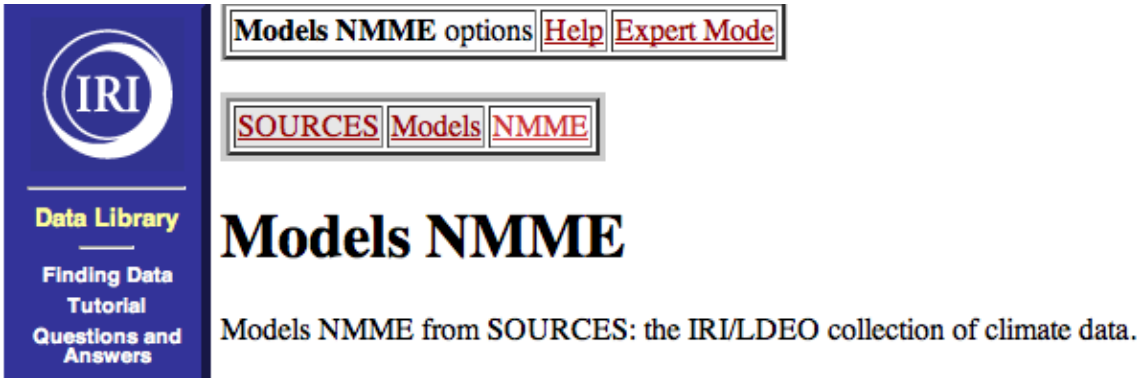
(After Kingtse Mo)

NMME Info and Data

NMME Data is open to the community:

Phase-I Hindcast data at IRI

iridl.ldeo.columbia.edu/SOURCES/.Models/.NMME/



Realtime forecast at CPC web site

www.cpc.ncep.noaa.gov/products/NMME/

NMME Overviews at CTB web site:

www.cpc.ncep.noaa.gov/products/ctb/nmme/

NMME – Phase II Plan

Main Goal: A more "purposeful" MME Experiment with improved models and an optimal experimental design to address key research questions

Funded by NOAA/MAPP, NSF, DOE and NASA

Tasks during FY12 and FY13

- **Continue Real-Time Experimental Predictions**
- **Enhance Current NMME Capabilities with model upgrades**
  Model Improvements: GFDL-CM2.5 (20 km AGCM), CCSM4, CESM1
- **Assess Forecast Quality**
  Consolidation techniques
  Drought Assessment: soil moisture, runoff, evaporation
- **Sub-Seasonal Assessment**
  Forecast Protocols
- **Initial Condition Sensitivity Experiments**
  Ocean, Land
- **Phase-II data will distributed at NCAR**
- **Phase-I Enhanced data (additional variables) will be continued at IRI**

Considerations to Sustain the NMME system after NMME Phase-II

- **Who runs the models?**
  - One promising suggestion is for the other modeling centers to continue to run their models and provide the reforecast and realtime forecast to NCEP
  - MOUs between NCEP and other modeling centers need to be signed
  - What about CCSM4.0 (currently run by U. Miami at NOAA GAEA)?
- **Who manages the data** (archive and dissemination)
- **Who provides financial support?**

ESPC Demo #1 directions

- Hypothesis: Blocking deficiencies may be addressable through improved coupled models (resolution, numerics, physics)
- What's new: next-generation global AMIP/CMIP models (higher resolution, modified numerics, readying for GPU/MIC computational era) (e.g., DCMIP)
- Expand laboratory links for planned collaboration for blocking research topics for prediction over 1-26 week duration
- Build on NMME community **operational** ties, also labs with WWRP/ WCRP/THORPEX **research** "Subseasonal to Seasonal Prediction Research Implementation Plan

Wednesday Demo #1 talks

- Randy Dole – Predicting atmospheric blocking
- Judith Perlwitz – Stratospheric ties with blocking
- Arun Kumar – CFSv2, blocking diagnostics, NMME overview

CTB Priority (2): CFS Evaluation and Improvements

- **To accelerate evaluation of and improvements to the operational Climate Forecast System (CFS) and to enhance its use as a skillful tool in providing NCEP's climate predictions and applications**

Past Supported CTB Projects:

Data Assimilation Methodology

- 150-yr Coupled ocean data assimilation (Cane, FY08)
- Hybrid data assimilation for reanalysis (Ide, FY09)

Model Physics Improvement

- Stratosphere (Perlwitz, FY09)
- CPT (Bretherton, FY10)

Empirical and Stochastic Parameterizations

- Stochastic perturbation (Delsole, FY06)
- Neural Network (NN) Emulation of model radiation (Fox-Rabinovitz, FY06)

FY13 Funding Opportunity:

- **MAPP Priority #2: Climate Process and Modeling Teams**
- **CTB proposals need to meet extra requirements for funding under MAPP-CTB Execution Agreement**

CTB Recent Efforts to Engage the Community in Development of next version CFS

Team efforts of NCEP, CPO, and the external community:

- **CFSv3 Planning Meeting in August, 2011**
- **CFSv2 Evaluation Workshop in April 30-May1, 2012**
  - Document improvement from CFSv1 to CFSv2
  - Identify model biases and deficiencies in CFSv2
  - Identify research directions for the development of CFSv3
- **CFS Strategy document**
- **Special CFSv2 Collection in Climate Dynamics**

NCEP CFS Strategy

1. **NOAA requirement for a CFS**
   - CFS is the operational model for seasonal forecast
   - CFSv2 needs improvement
2. **Developing a vision for NCEP CFS**
   - How bold and far-reaching should the vision be?
   - Should NCEP embrace a fully weather-climate modeling strategy?
   - Should CFS be a community model?
   - Should reanalysis be de-coupled from CFS model upgrades?
3. **Collaborative research and development process**
   - Initiate a fully unified weather-climate modeling strategy
   - Establish an NCEP Climate Modeling Team (NCMT)
   - Make NOAA collaboration with the external community more effective
   - Improve NCEP infrastructure, modeling framework and rewarding system
   - Accelerate the CFS development cycle and implementation cycle

NCEP Climate Modeling Team (NCMT)

NCEP Climate Modeling Team is established inside of NCEP to meet the requirement

- sustain climate-weather linkage in model development;
- be the “core identity” for climate modeling efforts at NCEP;
- provide an anchor for community participation in the model development process;
- be a collaborative EMC-CPC effort to leverage internal NCEP resources
- Integrate model diagnostics/evaluations into model development processes

What can CTB do for CFS Evaluation and Improvement?

(1) Engage the external community in planning for CFSv3

- **Workshops;**
- **Future CFS implementation plan**

(2) Provide grants funding to support R2O activities

- **Test and evaluate new parameterizations, schemes, model components in NCEP operational models**
- **Form Joint NCEP-External Modeling Teams**

(3) Provide NCEP in-house support to facilitate R2O

- **Support to external visitors and collaborators**
  - Model code, documentation, data, and technical support
- **Provide model testing environment that mimics NCEP operations**

CTB Priority (3): Improving Climate Forecast Tools/Products

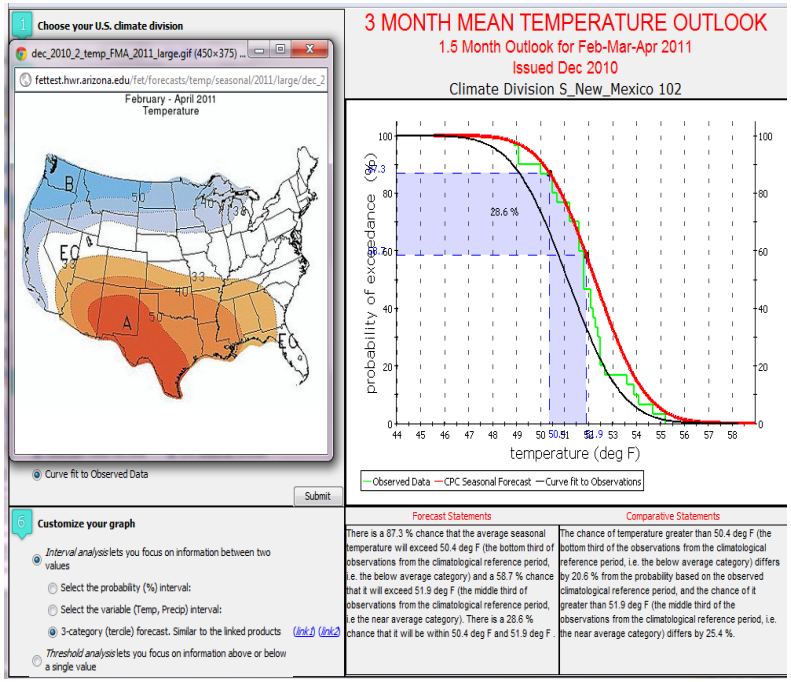
Goal: To provide reliable climate forecast products that are responsive to the needs of users and incorporate state-of-the-art science and research

CTB Past Funded Activities

- **Drought**
  - New tool for drought prediction (Lyon, FY08)
  - Drought Early Warning Index using satellite data (Anderson, FY09)
  - Drought monitoring and prediction products using NLDAS and CPPA results (Lettenmaier, Wood, Mo, FY10)

- **Forecast Tools, Assessment and Improvement**
  - Web-based Forecast Evaluation Tool (Hartmann, FY07)
  - Precipitation Prediction System over the Pacific Islands (FY08)
  - Probabilistic Forecasts of Extreme Events and Weather Hazards (FY08)
  - Enabling the Transition of CPC Products to GIS Format (Doty, FY08)
  - Seasonal Prediction for Ecosystems and Carbon Cycle (Zeng, FY10)

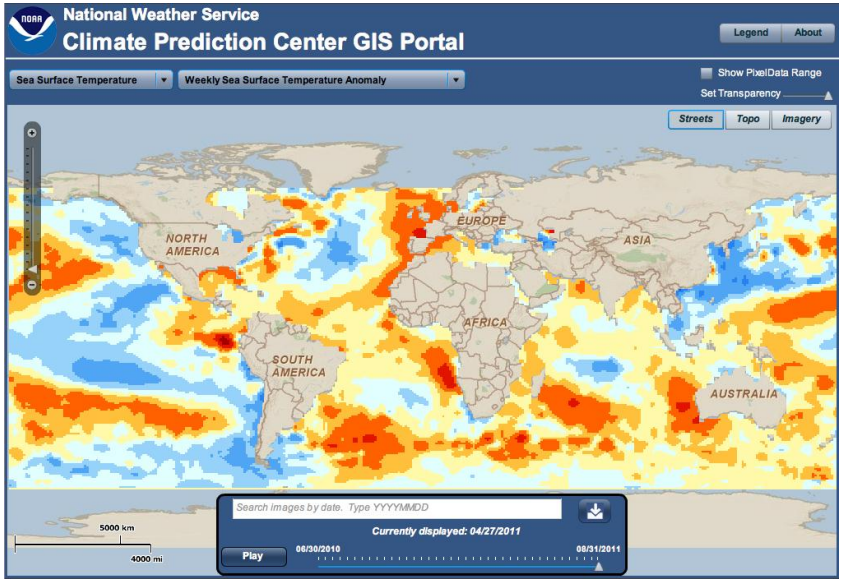
CTB Projects with specific R2O objectives are more successful in R2O Transitions



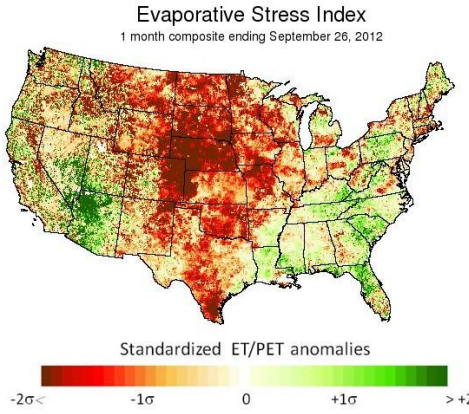
System-wide advancement of user-centric climate forecast product **(Hartmann, FY08)**

- **The system is maintained in developer's web site due to software compatibility**
- **CPC developed CPC version of Verification Web Tool**

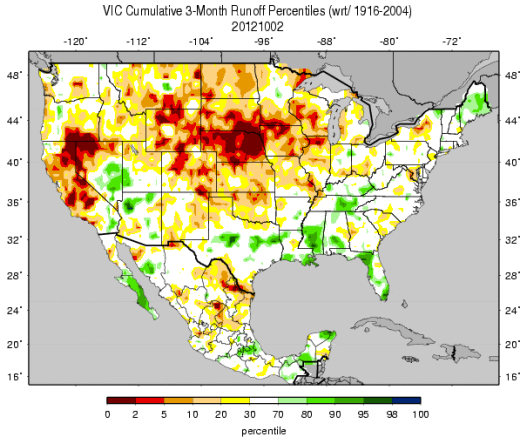
Enabling the Transition of CPC Products to GIS Format (**Doty, FY08**)



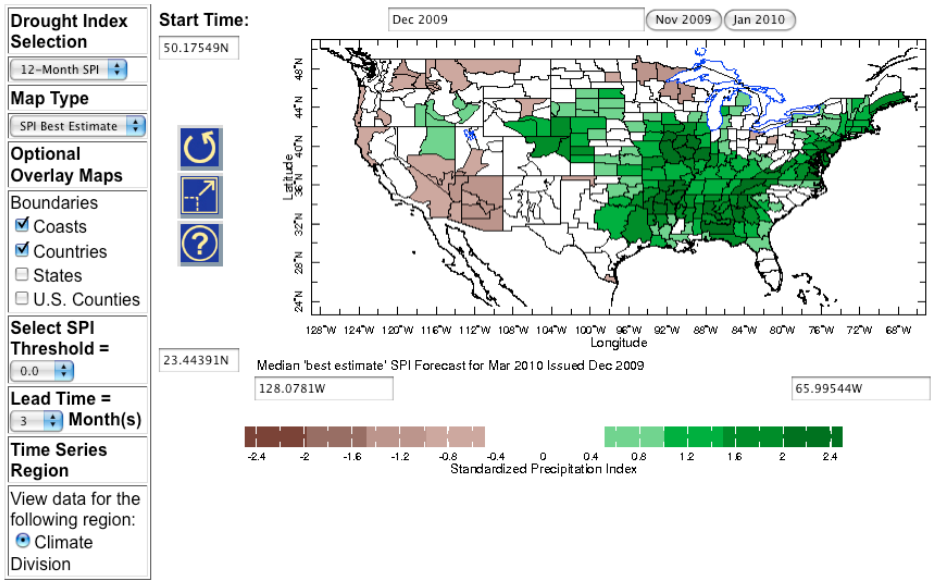
CTB Projects Improved Drought Monitor and Prediction Operations



Evaporative Stress Index (**Anderson, FY10**)



Enhancing operational drought monitoring and prediction products through synthesis of N-LDAS and CPPA research results **(Lettenmaier, Wood and Mo, FY10)**

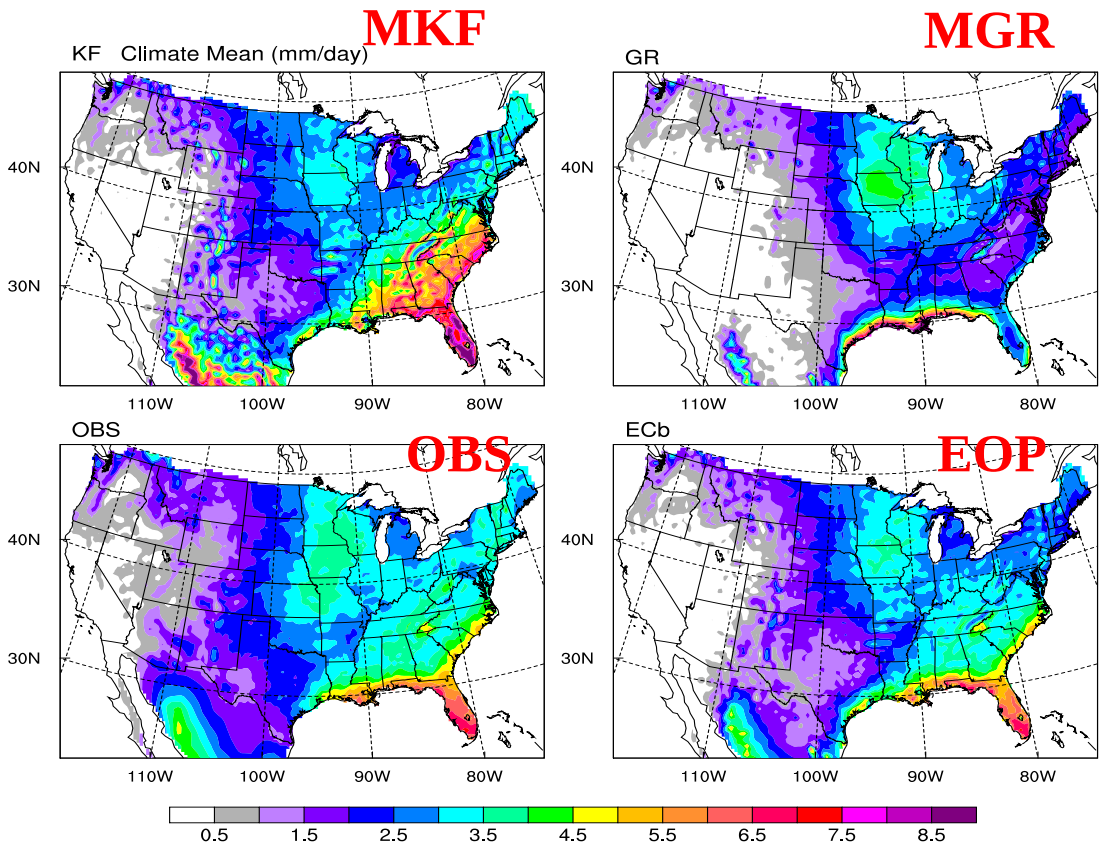


A prototype, web-based tool for assessing the initial and forecast drought state **(Lyon FY08)**

- **Leveraged on long-term research efforts**
- **Products are maintained by the external PIs and provided to operations in realtime; Transition is ongoing**

Potential New Activities to Improve NOAA Climate Forecast Products at Regional Scales

- **High-resolution GCMs**
- **Regional models (e.g., CWRF)**
- **Engage regional users via RISA connections**
- **Expand applications beyond drought products**



Can CWRF with Optimized-Physics Improve 2012 Summer Drought Predictions?
(after XZ Liang)

CPC-RISA Program

RISA	CPC Contacts	Areas of Collaboration
Southeast Climate Consortium (SECC)	Muthuvel Chelliah (CPC) Jim Jones, Keith Ingram, Jim O'Brien	Downscaling CPC Outlooks, Regional ENSO Impacts; Crop Yield Forecasting; Applications of high resolution GCM,CFS hindcasts.
Western Water Assessment (WWA)	Michelle L'Heureux (CPC) Andrea Ray	Intraseasonal forecasts and applications; Decision support re er
Climate Assessments for the Southwest (CLIMAS)	Ed O'Lenic (CPC) Holly Hartmann	Im de
Alaska Center for Climate Assessment and Policy (ACCAP)	Jon Gottschalck (CPC) Sarah Fleisher Trainor	De pr be pr
Pacific Climate Information System (PaCIS)	Luke He (CPC) Eileen Shea, Jim Weyman	Pa Training, Research for Improving Climate Service and Forecasts for the Pacific region.
California Application Program (CAP)	Kingtse Mo (CPC) Dan Cayan, John Roads	Soil moisture analyses from 4 NLDASs and regional reanalysis, CFS-based drought forecasts, MME applications to SI forecasts, week 1, week 2 E, P, soil moisture relationships from NLDAS.
University of Washington Center for Science in the Earth System (CSES)	Doug LeComte (CPC) Dennis Lettenmaier	Enhancements to U.W. surface water monitor, Improved tools for Drought Monitor and Drought Outlook.

- **Currently inactive due to lack of funding support**
- **Potential mechanism to engage regional users**

CPC/CTB Plan to Develop Forecast Verification Protocol and Baseline Assessment

- Build upon CPC's Verification Web Tool (VWT) for realtime verification
- Establish metrics/protocol/hindcast to evaluate CPC existing forecast tools
  - Provide a baseline to evaluate impacts of new forecast tools (including those from CTB funded projects)
  - Provide guidelines to retire old /nonskillful/unsustainable tools
- Involve users in the evaluation/assessment (thru RISAs?)
- Lead/Contribute/Leverage MAPP Drought Task Force Research to Capability (RtC) effort

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Key Elements for Successful R2O Transition

- The project objectives are NCEP requirement driven and R2O focused.
- Required “applied research” have been supported by other research programs
- Close involvement/partnership from NCEP is critical
- NCEP In-house O2R support is critical.

Reasons for Failing R2O Transition

- **Negative testing results**
- **Insufficient support from NCEP (model access, data, collaborators)**
- **Software incompatibility**
- **Less focused on R2O. Some projects have demonstrated potentials, but need additional time/effort/funding to test in an operational environment or for the upgraded model system**

Importance of NCEP – External Partnership and NCEP In-House Support

- **Allow CTB funded projects to leverage NCEP internal R&D efforts** (e.g., van den Dool's work in several CTB projects)
- **Effectively feedback CTB R2O research into implementation at NCEP operations** (e.g, NMME Phase-I)
- **Provide operational guidelines to the external collaborators**
- **The partnership is made possible through the CTB funding**
- **The NCEP in-house support is organized in an ad hoc approach**
- **Supporting the needs of a broader community is beyond NCEP's current capability** (e.g., model documentation, data access)

Plan to Improve the CTB management Approach: New Additional Requirements to Select MAPP-CTB Projects

- MAPP-CTB proposals must include a section with metrics to be used to evaluate the outcomes of the project and assess readiness for transition into NCEP's operations.

- MAPP-CTB proposals must include co-PIs or collaborators from NCEP.

- MAPP-CTB proposals must include a support letter from NCEP (CTB, CPC and EMC).

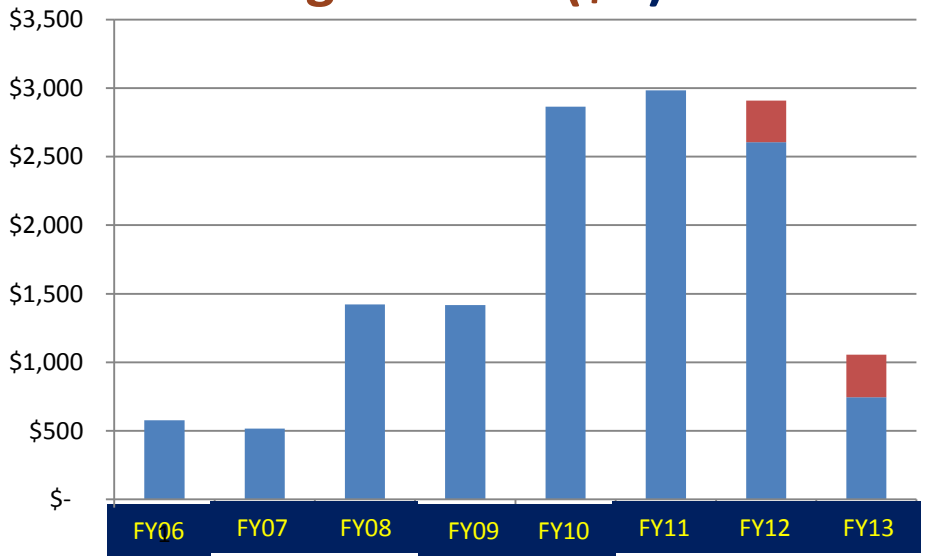
- Only one proposal will be submitted to CTB in FY13 under this new requirement.

Plan to Improve the CTB management Approach: New Additional Requirements to Manage MAPP-CTB Projects

- MAPP-CTB projects will be jointly overseen by a MAPP Program Manager and the NCEP CTB Director.
- Within 90 days of the end of the project, the CTB Director will organize a formal review of the project's outcomes which will involve the CTB Director, MAPP Program Managers, EMC Director, and CPC Director.
- A written summary of the review will be prepared and distributed by the CTB Director.
- Is there a need to review all past funded projects and test/evaluate the potential for R2O transitions?

History of CPO Funding for CTB

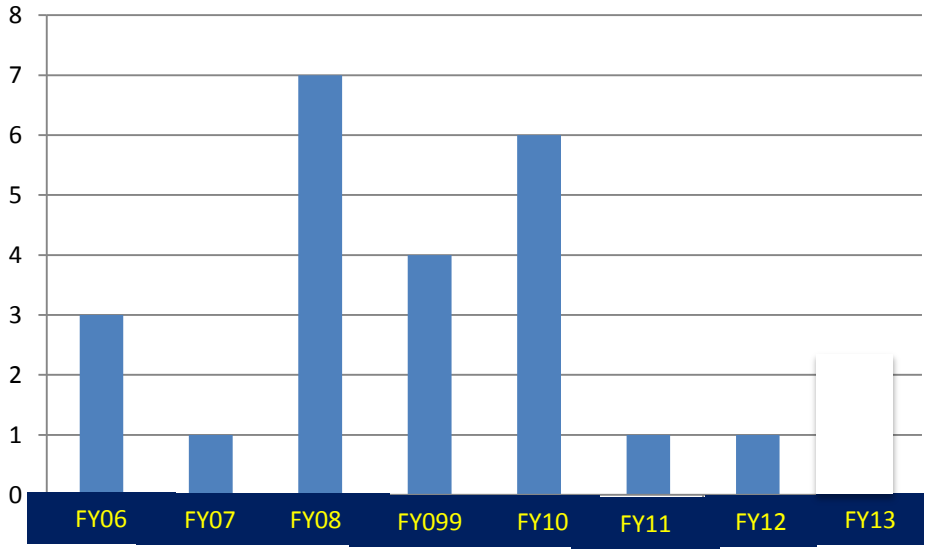
Funding amount ($K)



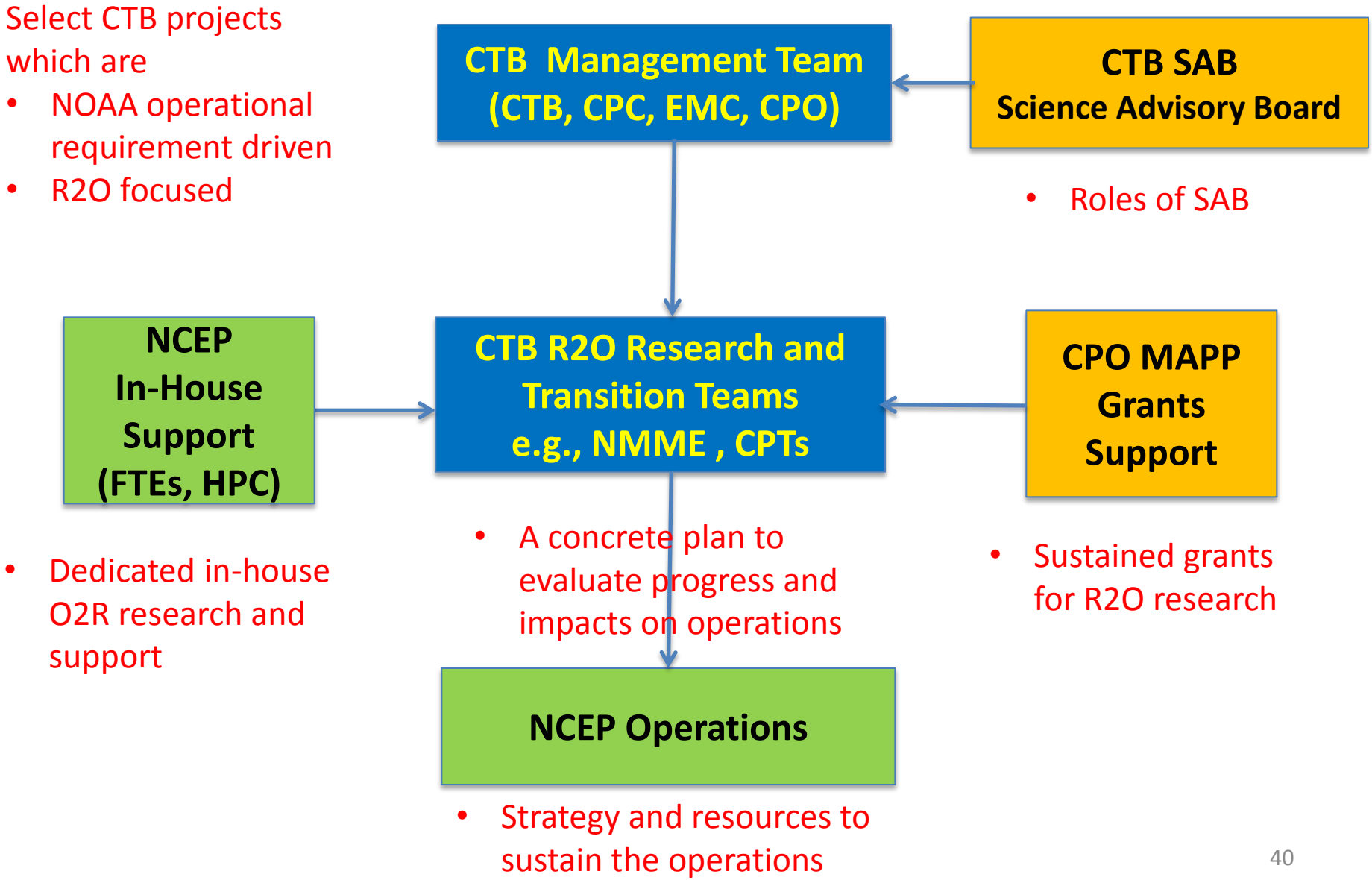
Funding from DOE,NSF, NASA

- There is only one CTB project left in FY13
- There is a potential for one new CTB project in FY13 depending on CPO budget and proposal reviews

Number of new projects



How to Make CTB Function?



Example:

Joint Center for Satellite Data Assimilation

JCSDA Modes of Operation

- Directed research
  - Carried out by the individual partners
  - Mixture of **dedicated and leveraged** funding from other programs
  - JCSDA plays a coordinating role (ideally)

- External research
  - Grants or Contracts awarded following proposals submitted to Federal Funding Opportunities administered by the partners
  - Open to the broader (external) research community
  - Funding awarded competitively, peer review process

- Visiting Scientist Program

Summary

1) CTB is a mechanism and a platform for NCEP to accelerate improvements of NOAA ISI operations through collaborations with the external community

2) Improved management approach will make R2O transition more effective

3) Sustained grants support and dedicated in-house O2R support are needed